

Appl. No. 10/732,877
Amendment and Response dated March 8, 2007
Reply to Office Action of December 8, 2006

REMARKS

Applicant acknowledges receipt of the Office Action dated December 8, 2006, in which the Examiner entered a Restriction Requirement for previously elected Claims 22-26, 28-36, 39-60. The Restriction Groups were set out as follows:

Group I. Claim 1-12 drawn to a reactor system; and

Group II. Claims 13-37 drawn to a method of oxidation of hydrocarbons.

Election without Traverse

With this Response, **Applicant affirms the election of the invention of Group II** (i.e., Claims 13-37) without traverse. Applicant reserves the right to prosecute the non-elected invention of Group I (i.e., Claims 1-12) in a later-filed divisional application. Claims 1-12 are now canceled.

Status of the claims

By this response, Claims 13-15, 19, 23, 24, 26, 27, 31, 34, 35, 37 are currently amended. Claims 1-12 are canceled. Claims 38-49 are newly added.

Claims 13-49 are currently pending.

Amendments to the Claims

Claims 13, 23, and 37 were amended to insert the following limitation: “*wherein said forming step comprises passing the hydrocarbon gas and the oxygen-containing gas through said portion of liquid at a total gas superficial velocity of between about 5 cm/sec and about 60 cm/sec*”. This amendment is supported by the application as filed, for example by at least original Claims 8, 14 and 24 and paragraph [0052] on Page 12 of the specification as filed.

Claims 14 and 24 were amended to narrow the *superficial velocity range between 10 cm/sec and 60 cm/sec*. This amendment is supported by the application as filed, for example by at least paragraph [0052] on Page 12 of the specification as filed.

Claims 19 and 27 were amended to correct a typographical error in these claims, i.e., to remove ‘psig’ after ‘3350 kPa’. This amendment is supported by the application as filed, for example by at least paragraph [0045] on Page 9 of the specification as filed.

Claims 15 and 26 were amended to correct a minor typographical error. This amendment is supported by the application as filed, for example by at least the Abstract and the last sentence of paragraph [0016] on Page 4 of the specification as filed.

Claims 31, 34 and 35 were amended to correct antecedent basis issues. The use of ‘reaction zone’ is supported by original Claim 13 and paragraphs [0052]-[0053] of the specification as filed.

These amendments do not constitute new matter.

Rejection under 103(a) over Hills

Claims 13-22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,269,791 by Hills (hereinafter ‘*Hills*’).

Hills teaches an improved technique for mixing a plurality of gases to be used for diving and other applications. More specifically, the technique provides for the mixture of gases as hydrogen and oxygen while decreasing the likelihood of explosion during mixing. Particularly, *Hills* discloses that hydrogen and oxygen bubbles are introduced into a column of liquid through needle injectors positioned in a region of turbulent liquid flow (see *Hills*’ Abstract). The liquid is continuously recycled by a pump to maintain the turbulent flow to provide the desired mixing (see *Hills* Col. 3 lines 23-25). Transfer of gas across the fluid boundary between bubbles causes equilibration of the bubbles to achieve mixing in the supplied ratio (see *Hills* Col. 3 line 56 to Col. 4 line 3).

Thus, in *Hills*’ apparatus and method, the mixing of the gases primarily occurs through gas diffusion into the liquid phase and then diffusion from the liquid phase into the gas phase, and not through gas-to-gas transfer via bubble interactions by coalescence and breakage as in the present invention (see Specification [0016] on Page 4 as originally filed). Second, the turbulence of the liquid in *Hills* is achieved by a pump (see *Hills* Col. 3 lines 23-25), unlike the gas-induced turbulence effected by a high gas superficial velocity as in the present claimed invention of Claims 13-22. The bubble sizes described in *Hills* are in the range of 50 to 100 microns (see *Hills* Col. 3 lines 31-37), and Applicant believes that these very small-sized bubbles do not induce massive liquid turbulence, since a pump for liquid recirculation is required in *Hills*’ system to provide sufficient liquid turbulence.

With respect to the gas superficial velocity limitation of original Claim 14 now inserted into claim 13, the Examiner acknowledged that *Hills* does not mention the superficial velocity of gases. The Examiner though states in paragraph 7 on Page 5 of the Office Action that the disclosure by *Hills* of controlling the bubble diameter from the diameter of nozzles would led one having ordinary skill in the

art (at the time the invention was made) to an obvious variant of *Hills'* method by controlling the superficial gas velocity within the claimed range (5-60 cm/s) to produce the desirable bubble sizes as disclosed by *Hills* for proper mixing within the tank.

Applicant believes that the disclosure of controlling the bubble diameter from the diameter of nozzles does not necessarily provide to the artisan with a teaching in controlling the gas superficial velocity in the tank to achieve the desired bubble size, since the control of the bubble diameter can be achieved independently of the gas superficial velocity in the tank, for example by changing the size of nozzle orifices (for a given gas flow rate) or the type of gas distributors. Moreover, *Hills* fails to disclose critical information such as gas flow rates and cross-sectional area of the tank which are necessary to estimate the gas superficial velocity. Thus, Applicant submits that *Hills'* disclosure of desirable bubble sizes in the range of from 50 to 100 microns for H₂-O₂ gases injected in water (see *Hills* Col. 3 lines 31-37) is not sufficient for an artisan to determine that the superficial velocity of the gases is necessarily in the range of 5-60 cm/sec to achieve these bubble sizes. The superficial velocity of the gases may be well below 5 cm/sec to achieve these bubble sizes.

As evidentiary support, see for example Figure 6 on Page 1493 of Prince *et al.* (1990) AIChE Journal, Volume 36, Issue No. 10 (hereinafter "Prince *et al.*"), this journal article being cited in PTO-1449 form submitted by Applicant on May 27, 2004. Prince *et al.* studied the impact of gas superficial velocity on bubble size in a gas-injected bubble column where a nitrogen gas containing tracer gases was fed via a plurality of 2-mm orifices. As shown in Figure 6 of Prince *et al.*, the smallest bubble size of 516 microns or 0.52 cm (from the lowest *ca.* 0.018 cc bubble volume shown in Figure 6) was obtained with a gas superficial velocity of 0.5 cm/sec (assuming spherical bubble shape) at the bottom port. Figure 6 in Prince *et al.* further shows, for a bottom port, a trend of increasing bubble size with increasing superficial gas velocity until a plateau is reached for the bubble size. Prince *et al.* explains that there is a maximum in the bubble size as a function of gas flow rate due to competing effects of bubble coalescence and breakup. It can be inferred by the artisan from this teaching that *Hills* would use even smaller gas superficial velocity (i.e., less than 0.5 cm/sec) to achieve these very small-sized gas bubbles (0.05-0.1 cm) in this particular system. Because the mechanism for gas-to-liquid-to-gas mass transfer to effect H₂-O₂ mixing by equilibrium in *Hills'* method is indeed largely affected by the surface area of the bubbles/liquid boundary (i.e., small size bubbles), there would be no motivation in the artisan to increase the gas superficial velocity in the range (5-60 cm/sec) claimed in the present

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invention, as doing so would create larger bubble size and/or would further induce more bubble collisions, both of which are not intended nor desired by *Hills*.

As for the pressure of the mixing system, Applicant is unsure how a turbulent flow in the liquid would cause the system to be under pressure (as stated in paragraph 11 on Page 6 in the Office Action). A gas in a turbulent liquid does not necessarily cause the gas to be under pressure. Applicant respectfully requests the Examiner to further clarify this statement. If an artisan uses elevated pressure (as in the range claimed in Claim 19) in the mixing tank of *Hills*, the solubility of the gases (such as oxygen and hydrocarbon) in a liquid (such as water) would be expected to decrease; in which case the driving force of gas-to liquid mass transfer which is the first step of *Hills*' gas mixing method would also be reduced, thus providing a slower mass transfer rate from gas to liquid. Working at elevated pressure in the mixing tank of *Hills* thus would decrease the effectiveness of *Hills*' gas mixing method.

For at least the reasons stated above, the rejection of Claims 13-22 over *Hills* is not *prima facie*, as the *Hills* reference fails to disclose each and every element of independent Claim 23 and *a fortiori* of its dependent Claims 14-22, as required for obviousness (see **MPEP 2143.03**); and further the *Hills* reference does not suggest nor provide sufficient motivation to an artisan to arrive to the present claimed invention of Claims 13-22 with a reasonable expectation of success (see **MPEP 2143.02**).

Applicant respectfully requests the Examiner to withdrawn the 103 (a) rejection over *Hills* on Claims 13-22.

Rejection under 103(a) over Hills in view of Hershkowitz

Claims 23-37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *Hills* in view of U.S. Patent No. 5,883,138 by *Hershkowitz* et al (hereinafter ‘*Hershkowitz*’). *Hills* does not teach using a reaction zone, but the Examiner has used *Hershkowitz*’s teaching about an injector/reactor apparatus and its use in an efficient process for the partial oxidation of liquid hydrocarbon gases to supplement what is missing from *Hills*’ teaching.

Hershkowitz teaches the mixing of reactant gases, such as light of hydrocarbon gas (including methane) and an oxygen-containing gas, which are injected through an injector means at extremely high speeds, up to sonic speeds, into admixture with each other in the desired proportions, at a plurality of mixing nozzles which are open to a catalytic partial oxidation reaction zone of a reactor and are uniformly-spaced over the face of the injector (see *Hershkowitz* Abstract & Col. 6 lines 57-60) and

closely-spaced alignment with the face surface of the ejector (see *Hershkowitz* Col. 9 lines 15-16), to form a reactant gaseous premix. The velocity of the homogeneous gas mixture as it is ejected from the mixing nozzles is from about 25 to 1000 ft/sec (see *Hershkowitz* Col. 7 lines 7-11).

The Examiner stated in Paragraph 16 on Page 8 of the Office Action that *Hershkowitz*'s system of mixing is similar to that of *Hills*, except that *Hershkowitz* does not use a liquid for mixing gases. But this difference is not trivial to an artisan. *Hershkowitz*'s system and method of mixing further differs from *Hills'*, in that the gases are injected *at extremely high speeds into admixture with each other* in the desired proportions, that is to say the mechanism for mixing in *Hershkowitz*'s is by direct gas-to-gas mass transfer while achieving *ca.* 25 to 1000 ft/sec speed in the ejectors. Such speed is required by *Hershkowitz* to provide a dwell time of the gas mixture within or immediately above the injector surface prior to passage into the reaction zone to less than about 5 milliseconds.

Applicant submits that *Hershkowitz* does not remedy to *Hills*'s failure to disclose a gas superficial velocity range as recited in the present claimed invention of Claims 23 and 37, and their respective dependent claims.

Applicant further submits that the substitution of *Hershkowitz*'s gas mixing method for providing a reactant gas with the method of *Hills* as suggested by the Examiner to arrive to the present Claims 23-37 would not provide an effective gas delivery for the *Hershkowitz*'s downstream partial oxidation zone. As explained in the above section, *Hills*'s primary mechanism of gas mixing is via gas-to-liquid-to-gas mass transfer which can be achieved by a large surface area (bubble/water boundary), that is to say with very small-sized bubbles (50-100 microns), while avoiding excessive bubble collision. Because the mass transfer will be limited by the diffusivities of the gases into the liquid and because this additional resistance to mass transfer requires more time than gas-to-gas mass transfer, it seems unlikely that *Hills*'s system will be able to deliver a mixed gas at a local gas velocity of *ca.* 25-1000 ft/sec to the close-proximity reaction zone of *Hershkowitz*'s system. Moreover, a dwell time of the gas mixture within or immediately above the injector surface prior to passage into the reaction zone of less than 5 ms requires that the level of liquid from *Hills*' tank is very closely-spaced alignment with the face surface of the reaction zone, which would not provide *Hills* enough room to add the drying unit to eliminate water vapor from the gas mixture prior to use (see *Hills* Col. 4 lines 53-60).

Additionally, *Hershkowitz*'s process is designed to be operated at elevated gas pressure. Thus, *Hill*'s gas mixing method will need to operate at elevated pressure as well. However, as explained earlier, elevated pressure in the mixing tank of *Hills* is expected to decrease the solubility of the gases

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(such as oxygen and hydrocarbon gas) in a liquid (such as water), which would reduce the driving force of gas-to liquid mass transfer which is the first step of *Hills'* gas mixing method. Working at elevated pressure thus would decrease the efficacy of *Hills'* gas mixing method of *Hills* and would not be suitable for delivering a well-mixed gas reactant gas at close-to-sonic speed to the reaction zone of *Hershkowitz*.

Applicant thus argues that the combination of these references proposed by the Examiner does not have a reasonable expectation of success for providing a reactant gas at such a high gas velocity and further at elevated pressure.

For at least the reasons stated above, the rejection of Claims 23-37 over the combination of *Hills* with *Hershkowitz* is not *prima facie*, as such combination of references fails to disclose each and every element of independent Claims 23 and 37, as required for obviousness (see **MPEP 2143.03**) and further such combination of references does not suggest nor provide sufficient motivation to an artisan to arrive to the present claimed invention of Claims 23 and 37 with a reasonable expectation of success (see **MPEP 2143.02**).

Applicants respectfully request the Examiner to withdraw the 103 (a) rejection over the combination of *Hills* with *Hershkowitz* on Claims 23-37.

New Claims 38-49

Applicant added new Claims 38-49 in order to cover additional embodiments of the methods of Claims 13, 23 and 37. Claims 38-44 are dependent or ultimately dependent from independent method Claim 13. Claims 45-47 are dependent or ultimately dependent from independent method Claim 23. Claims 48-49 are dependent or ultimately dependent from independent process Claim 37. Applicants believe that new Claims 38-49 do not constitute new matter and are supported by the application as follows.

- Claim 38, 47 and 49 are supported by at least the end of paragraph [0052] on Page 12 of the specification as filed.
- Claim 39 is supported by at least Figure 8; paragraph [0055] on Page 13 and paragraph [0057] on Page 14 of the specification as filed.
- Claim 40 is supported by at least paragraph [paragraph [0055] on Page 13 of the specification as filed.

- Claims 41 and 42 are supported by at least original Claims 6 and 7, respectively.
- Claim 43 is supported by at least paragraph [0024] on Page 6 of the specification as filed.
- Claim 44 is supported by at least paragraph [0047] on Page 10 of the specification as filed.
- Claim 45 is supported by at least the Abstract; Figure 10; and paragraph [0060] on Page 15 of the specification as filed.
- Claim 46 is supported by at least the Abstract; Figure 2.
- Claim 48 is supported by at least original Claims 13 & 24 and paragraph [0052] on Page 12 of the specification as filed.

Because these new claims depend from independent claims of the elected invention of Group II, Applicant respectfully requests these new Claims 38-49 to be considered as part of the elected invention of Group II. Furthermore, because each of these new claims carries with it the limitations of the independent claim (patentable over the cited art) from which it depends, Applicant believes that these new claims are patentable as well and respectfully requests their allowance.

Amendments to the Specification

Paragraphs [0014], [0020], [0046], [0052]-[0055], [0060], [0064] have been amended to correct minor typographical errors and/or to improve grammatical form. All cited paragraph numbers originate from the specification as filed.

No new matter was added by way of amendments to these paragraphs of the specification.

Conclusion

Applicant believes that this response fully responds to the Office Action dated December 8, 2006 and is timely filed within the 3-month shortened statutory deadline as set in this Office Action, so that no additional fee is required. Applicant believes that Claims 13-49 representing the claimed invention of Group II are allowable. Applicant respectfully solicits their allowance.

Applicants further believe that the cancellation of 12 claims in this Response is sufficient to cover the addition of 12 new claims (i.e. Claims 38-49) so that no additional claim fee is required. However, should any fees have been inadvertently omitted, or if any additional fees are required or have been overpaid, or in the event that an extension of time is necessary in order for this submission to be considered timely filed, the Commissioner is authorized to appropriately charge or credit those

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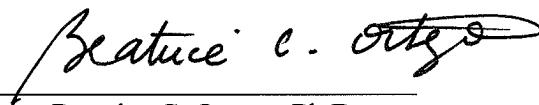
fees to **Deposit Account Number 16-1575** and consider this a petition for any necessary extension of time.

If resolution of any remaining issues pertaining to restriction groups and election may be facilitated by a telephone conference, or if the Examiner has any questions or comments or otherwise feels it would be advantageous, the Examiner is encouraged to telephone the undersigned at (281) 293-4751.

Respectfully submitted,

CONOCOPHILLIPS COMPANY - IP LEGAL

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